TRANSECTS IN THE ARRIGETCH CREEK VALLEY

BROOKS RANGE, ALASKA 1978

CONTRACT PX-9000-8-0868

UNITED STATES DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE

DECEMBER 25, 1978

David Jonathan Cooper

Ann Marie Odasz

TABLE OF CONTENTS

INTRODUCTION

Permanent transects were established in July and August 1978 in the Arrigetch Creek valley. The transects and environments are described in this first part of a planned long-term project in the academic and professional life of the primary author D.J. Cooper who plans to continue active research in the Arrigetch Peaks in particular, and on regional ecology in general. This report summarizes one years research and forms the basis for the planned research endeavors of future years.

The area is noted for its spectacular scenic qualities, and has already become one of the most popular visitor areas in the recently established Gates of the Arctic National Monument. At present a few dozen hikers and climbers frequent this valley in the summer season, and a very few during the winter and spring months. Thus the effect of human impact upon the natural ecosystems is of vital consideration in developing defensible land use plans for this area.

Visitors usually begin their hike into Arrigetch from an ox-bow lake in the Alatna River valley commonly called Circle Lake. There is approximately an 8-mile hike over varying terrain to the peaks of Arrigetch. The first three miles are in the Alatna valley. Hummocks with Sphagnum spp., Shrub birch, and cottongrass tussocks are mixed with patches of Black spruce, Alder, and Willow thickets. There is no established trail across this terrain; walking is extremely difficult. At the mouth of Arrigetch valley are a series of dry hills. Many visitors camp here for one night before continuing their hike into Arrigetch. The environment of these hills supports only very limited plant growth. Consequently, trampling by visitors has already eliminated most plants from the tops of these hills.

The remaining hike up valley is on the north-facing slope. A braided series of trails is unofficially maintained by trampling. The valley gradient is not steep, and White spruce, open patches of Alder, and open meadows allow easier movement.

Most visitors camp in an open stand of White spruce along Arrigetch Creek. The area is located near present timberline. This summer, out of approximately 160 man-days (by other visitors than the researchers), 81 of these days were spent camped at this main campsite. All ten transects are located around this site.

A total of 22 people visited Arrigetch between June 1, and August 20, 1978. From reports by Ray Bane (a National Park Service employee), and other people in Bettles, we anticipated a larger number of visitors. In the past up to 20 people had been reported to have been in the Arrigetch Creek valley at one time.

The first widely-known reports of visits by white men in this area were by Bob Marshall in the mid-1930's. Today access is much easier, and the popularity of these remote mountains is increasing. Some incidents observed this summer that inflict great impact on the land include:

1. Sawing down whole dead spruce trees for campfires. This leaves permanent scars in the form of stumps.
2. Leaving trash (eg. food cache cans) in the area.
3. Camping on lichen tundra-covered hills, which immediately impacted the vegetation.
4. Hiking in parties over lichen-encrusted rocks. This breaks the lichens off when they are dry and brittle, leaving rocks.
5. Continual use of any area destroys the vegetation and creates bare areas.

The Arrigetch Peaks area is of tremendous scenic value, and visitor use is expected to increase because publicity in mountaineering and climbing journals has enticed increasing numbers of visitors to explore the area. The land is still pristine.

Thus, an excellent opportunity exists to develop long-range management policies. As data are accumulated, it will provide a basis for determining such control policies as the number of visitor-days per year to be allowed, permissible types of visitor activities, fire sites, waste disposal, and fuel sources.

It is to develop an early understanding of the effect of human activities upon these ecosystems that this research is directed.

GENERAL PHYSIOGNOMY

The Alatna River drains a large segment of the central Brooks Range. (See map #1). Its headwaters are near 68^{o} North latitude. It flows South approximately 150 miles, adding this water to the Koyukuk River where the native villages of Alatna and Allakaket are located. The area is roadless and for the most part trailless wilderness. Mountains are large and rugged ranging in elevation (mostly) between 5-7000 feet (1600-2300 meters). The valleys are broad, and open basins are common.

The highest and most rugged mountains in this river system are located in an area drained by Arrigetch Creek. It is a tributary entering the Alatna from the southwest. In the same area the Kutuk River enters the Alatna from the northeast. It is an area of granitic intrusive. Here the bedrock is more resistant to erosion than the limestones and shales which comprise much of the Brooks Range.

Arrigetch Creek valley is oriented east northeast, south southwest, and at its source are three main valleys. For identification purpose in this report we have named them the North fork, a central Lake fork, and a southerly Cathedral basin.

The North fork is the largest valley,(see map #2). There are steep walled peaks at the head, where many cirques still contain small active glaciers. The highest peak in the area is found here with a summit of 7190 feet. The upper river segment in this valley is of low gradient. It appears as though glacial rock flour and silts have filled an ancient lake. Further down this valley the creek cuts a small canyon through erodable limestone bedrock. Here the gradient increases to meet the baselevel of the main Arrigetch Creek valley. The lower portion of this water source is a floodplain through which the major waters flow into

Arrigetch Creek.

In the central Lake fork are several alpine lakes. They are small, deep bodies of water bordered by talus slopes and sheer walls of granite. The stream is steep in its lower stretches cascading over terminal moraines.

The next valley south, Cathedral basin, is bordered on the south and west by a 3000 foot (1000 meter) sculptured vertical ridge of granite. There is a small glacier pocketed in the head of the cirque, and a series of terminal moraines. Two areas support vegetation. The basin ends abruptly and its water plunges over yet another terminal moraine. Flowing to the north it converges with the flow from the Lake fork. This confluence area is wide with steep valley walls. There is low gradient where the two creeks come together. This area is marshy. The gradient increases downstream and the creek is shallow with many exposed boulders. A small waterfall of approximately 30 feet (10 meters) is found just before this water merges with that from the North fork. Here the main body of water is called Arrigetch Creek and flows down the broad, deep valley. The creek waters flow rapidly until reaching the Alatna River valley where it slows, broadens, and enters the Alatna River. There are four small tributaries that enter Arrigetch Creek enroute to the Alatna. These streams all come from the south.

CLIMATE

Brooks Range landscapes today are largely a product of past climates. Large ice sheets were developed and supported during glacial periods of much greater precipitation. Present annual temperatures in the Brooks Range are still low enough to support large glaciers. However precipitation is too slight to exceed ablation and produce accumulation of ice.

In the Arrigetch valleys small glaciers do occur, probably reflecting the microclimatic conditions of both cooler summer temperatures, and higher precipitation, caused by the great height of the mountains.

Permafrost is found throughout the area. An active (thaw) layer of 1-2 feet is common during summer months. Along streams and lakes, where water temperatures influence, the permafrost is depressed.

WEATHER

The summer of 1978 (June 3 to August 13 in the Arrigetch valley), was one of great diversity in weather. The high temperature was 76° F, and the low was 28° F. Almost all winter snow was melted when we arrived though it did linger throughout the month of June in north-facing snowbank areas and in the high basins.

June was cool with the temperature rarely above 50° F. Clouds and rain dominated the weather 60 % of the time. We recorded approximately 4.5 inches of precipitation during the month, and it snowed 3 times in the valley bottom. The high peaks and ridges received snow several more times.

July was less rainy and we observed a distinct change in temperature. It seemed as though air masses were warmer which coincided with a time of rapid plant growth and flowering. There was a distict period of glacial ice melt which caused the rivers to rise during this time. On a few occasions the crossing of these rivers was impossible. Daily rains were common. We made two trips to the Alatna River valley during this month. We enjoyed warmer and drier conditions there. However, upon return to our camp at the Arrigetch Peaks we usually discovered wet ground and continuous cloud cover. These observations seem to indicate a cooler, more shaded microenvironment of higher summer precipitation is caused by cloud and condensation formation by the Arrigetch Peaks.

August began with a long streak of clear, dry weather. This lasted about 10 days. Toward the middle of the month Autumn colors began to appear on the Arctostphylos rubra, Alder and a few other species. Nightly frost is also common in August.

GEOLOGY

The major portion of the Brooks Range is composed of folded and faulted sedimentary bedrock. Skajit limestones of Devonian age, and various shales comprise most of the bedrock mountains in the Alatna River drainage. It produces a landscape of dipping strata and easily erodable rock.

There is a large area of Cretaceous granitic intrusive stretching from the Alatna River area toward Walker Lake to the southwest, and Mt. Igikpak to the northwest. The rock is extremely durable and these mountains are some of the highest in the western portion of the Brooks Range.

The area has been glaciated several times during the Pleistocene. Valley walls are steep, and bottoms broad. The areas temperature continues to support glaciers. Precipitation is low enough that summer ablation keeps winter accumulation minimal in all but the highest and most shaded areas.

Glacial activity has been dominant in shaping this landscape. In the Arrigetch area, glaciers have carved deep valleys into the granite. In several places the glaciers have followed the contact between granite and limestone, carving along the strike of the intrusive. This produces valleys with granite walls on one side, and limestone on the other. In other places the glaciers have carved into the granite parallel with the strike producing magnificent smooth faces all the way to the ridge on both sides of the valley.

There are several levels of what appear to be kame terraces in the main valley. These are easily seen on the South side of the valley. The lowest level is the largest. It is perhaps one mile long, 200 meters wide, and 100 meters above the present day ceeek. These terraces appear to be of much lower gradient that does the creek.

The valley bottoms are covered with Quaternary deposits of undifferentiated alluvium. Small tributaries cut into the limestone valley sides in weakened fracture zones. Alluvial fans spread to the valley bottom in many places. These have been truncated by the eroding Arrigetch creek.

Talus slopes of angular granite are common in any steep, unvegetated area of the Arrigetch Peaks. Small avalanches were common in June and early July as sheets of snow and ice fell from granite faces. Rock fall avalanches were suprisingly frequent in two chutes on the face of one mountain. In that area the limestones are uplifted upon the granite to an almost vertical angle. The summer thaw apparently loosens and lubricates stones fractured by winter frost. In one chute oxidation seems to contribute to the weathering of underlaying granite thus weakening all sedimentary rock in that area.

Up the North fork valley are a series of small pingos. Here and in Cathedral Basin are stone stripes, protalus ramparts, and many related periglacial features. Solifluction lobes are common on all vegetated slopes. In some areas cracks up to one foot wide sepārated lobes where movement is rapid.

ANIMAL LIFE

Animal life in the Arrigetch Creek valley is limited mostly to small mammals, birds, and insects. One moose was seen. Evidence of grizzly and black bear is common. Dall sheep are scattered on the high ridges, though not abundant. Caribou migrate up the Alatna River valley in small numbers though none were seen during the summer months.

One short-tailed weasel was seen. Arctic ground squirrels were so common as to be a problem in keeping them out of food supplies. Tundra redback voles and an unidentified species of shrew were also frequented.

Many birds summer in the area. The following lists our observations of species, nests observed, habitat in which they were usually seen, and relative abundance.

Species	Abundance	Status	Habitat
Tree sparrow	common	nests	shrubs
Ruby-crowned kinglet	common	nests	shrubs
Snow bunting	few	nests	high basins
Common redpoll	few	?	tundra
Golden-crowned sparrow	nests	common	tundra & shrubs
White-crowned sparrow	nests	common	shrubs
Robin	nests	common	shrubs & forests
Varied thrush	nests	common	shrubs & forests
Gray-cheeked thrush	nests	common	shrubs & forests
Myrtle warbler	nests	few	shrubs & forests
Kingfisher	?	few	streams in forest

Species	Abundance	Status	Habitat
Upland plover	few	nests	marsh tundra
Northern shrike	few	?	forest
Mew gull	few	?	lakes
Water pipit	common	nests	high basins
Yellow wagtail	few	?	high basins

VEGETATION

The vegetation of the main valley of Arrigetch Creek is typified by trees and shrubs on alluvium and colluvium. Tundra vegetation is found above these fans and screes extending to and encompassing the ridgetops.

At the north end of the valley, just south of the Alatna River, one finds a continuous stand of trees and shrubs interupted occasionally by lighter colored vertical ribbons of Alder (*Alnus crispa*), which colonize the less stable limestone scree slopes. Black spruce (*Picea mariana*), is common in the forests and occupies the less well drained areas. White spruce (*Picea glauca*) occupies the the more well drained habitats together with Alder, Willows, (*Salix spp.*) Shrub birch (*Betula glandulosa*), and an occasional Balsam poplar (*Populus balsamifera*). The understory is extensive and includes, among other species, *Potentilla fruticosa*, *Vaccinium vitis-idea*, *Vaccinium uliginosum*, *Dryas integrifolia*, *Ledum palustre*, and *Epilobium latifolium*.

Continuing south up the Arrigetch valley one encounters boggy meadows with one-two foot high tussocks of *Eriophorum spp.*. In these poorly drained areas there is an abundance of bryophytes, Shrub birch, sedges (*Carex spp.*), and other hydrophilic vascular plants. In this lower portion of the valley White spruce seedlings are common, and an occasional paper birch (*Betula paperifera*) is found.

The many tributaries entering the Arrigetch Creek from the south offer lush, shaded environments with continuous summertime moisture and depressed permafrost. Large White spruce, Poplar, and Alder line these channels.

The north-facing side of the alluvial fans have a unique and distinctly different vegetation in a few areas. Here the ground is dry. Dryas sp., Carex sp., and Deschampsia sp. are the most important species.

The creek braids in a number of places where tributaries enter the main waters of Arrigetch Creek. Gravel and silt bars form islands of various shapes and sizes. The vegetation on these islands is prone to occasional submersion during spring runoff and heavy rains as the river rises. There is constant erosion from creek water on the upstream portion of the island with deposition of silts on the downstream shores. This process gives rise to a continual erosion, deposition and succession on the islands. The silt is initially colonized by Epilobium latifolium, mosses, Salix alaxensis, and various Carex spp.. Dryas integrifolia, Hedysarum alpinum, Parnassia palustris, and Tofieldia coccinea, thrive well on these new silt regions. Eventually well-developed vegetation covers the island. Alder, Willows, especially Salix alaxensis, S. glauca, and S. lanata, grow to 3 meters in height on these islands.

All ten transects are located along Arrigetch Creek at an elevation of approximately 2250 feet. They are on the South side of the creek on floodplain deposits of alluvium. The soils are well-drained and the area is on the truncated edge of a kame terrace that rises to the South. The side of the terrace is steep, and produces a northwest facing environment. The transects are located on less steep ground at the foot of the terrace. The slope is 0-10 degrees facing northwest.

White spruce flourish, Balsam poplar (_Populus balsamifera_) is common, and thick mats of _Hylocomium splendens_ carpet the bases of these trees. Alder, Willow, and a rich herb cover consisting of _Pyrola assarifolia_, _Dodecatheon frigidum_, _Ledum plaustre_, _Pedicularis spp_. _Carex spp_. and other species grow well in this riparian habitat.

Equisetum arvense is common in the poorly-drained areas on the more level kame terraces.

A few large raised mound (possibly bedrock), offer a dry-well drained habitat for a myriad of lichens including _Cladonia spp_., and _Cetraria spp_., and heaths such as _Ledum palustre_, and _Empetrum nigrum_.

The White spruce forests on the east side of the valley are fairly open with evenly spaced trees. Shrubs such as _Betula glandulosa_, _Salix glauca_, _S. alexensis_, and Alder, occur in varying abundances with the spruce.

The White spruce stands on the west side of the valley follow the well-drained alluvial fans 2-300 feet up the slope from the creek. The relative frequency of seedlings decreases with the increase in altitude, and a few Black spruce with ring-type growth morphology are found at the extreme treeline. Shrub birch, Willows, and Alder, interchange dominant roles in the shrub layer. _Vaccinium uliginosum_ and _Cassiope tetragona_ are abundant at the base of spruce trees, and in moister areas. _Dryas integrifolia_ _Carex spp_. grasses and lichens comprise the ground cover in the seemingly dry areas.

The area is very close to present treelimit, and trees are widely spaced. White spruce is the dominant tree species in this area. It attains heights of 8-15 meters, diameters to 26 centimeters at breast height, and ages to approximately 110 years. It is associated with patches of Alder in more moist sites, and willows toward streamside. The understory is mainly _Dryas integrifolia_, with _Salix reticulata_, _Arctostaphylos rubra_, _Carex sp._, _Hedysarum alpinum_, and lichens in the open areas between spruce trees. Under the trees and around the Alder is a more luxurient cover of _Cassiope tetragona_, _Vaccinium uliginosum_, and abundant mosses.

Trampling is most concentrated in areas where campers set up their tents, and along well defined trails. Open areas between trees are most prone to be trampled, and the areas under trees are not disturbed as frequently.

Large areas are almost completely denuded of vegetation. The increased action of needle ice and sheetwash over this area undoubtedly increases erosion. The real danger of this being in the loss of soil, and the seed bed for potential recolonizing species.

Arctic-alpine vegetation occupies the higher valley bottoms and sides on all but the most active substrates. In well-drained valley bottoms grow Alder, _Boykinea Richardsonii_, _Salix spp._, Shrub birch, with lush herbs and mosses. In poorly-drained valley bottoms, of low gradient are stands of cottongrass (_Eriophorum spp._), _Carex spp._ _Equisetum palustre_, and mosses. These valley bottoms are of very silty sediments and remain wet most of the year. Pingos in the North valley, are located in these wet areas. They produce a convex well-drained surface. On these grow Shrub birch, Willow, heaths, mosses, and lichens. They are like islands of botanical diversity created by cryogenic processes.

On well-drained coarse alluvium of the valley sides are large turf meadows. _Dryas octopetala_, _Vaccinium uliginosum_, _Arctostaphylos rubra_, _Salix reticulata_, _Silene acaulis_, grasses, sedges (_Carex spp._), with scattered mosses and abundant _Cetraria islandica_, and _Cladonia_ lichens. The fibrous roots of this plant community hold these soils and make them quite resistant to erosion. They can stand considerable trampling before rutting and erosion begin.

In wetter areas near streams are stands of tall willows like _Salix pulchra_, _Salix glauca_, and others. There is also an extensive cover of lush mosses over the entire ground surface.

Small bedrock hills support a prolific cover of _Cladonis alpestris_, and other _Cladonia_ lichens. With it is found _Cassiope tetragona_, _Loiseluria procumbens_, _Vaccinium vitis-idea_, _Salix pulchra_, _S. arctica_ subsp. _arctica_, _Campanula lasiocarpa_, other herbs, grasses, mosses and lichens. These are perhaps the most easily disturbed communities in the area. There is usually several inches of detritus, (presumably of lichen origin) under the present cover of lichens. The living material dries out quite readily during periods of dry weather. The detritus layer however stays moist. A footstep here will crumble the dry living lichens and compact the moist detritus. This step easily slips downhill on the lubricated interface of detritus and underlaying substrate. It can produce a bare skid mark and disorganized pile of lichens with each step. These areas should be avoided by visitors.

Large areas of stable granitic talus are covered with lichens. Umbilicaria spp., Sphaerophorus sp., Alectoria sp., Parmelia sp. are among the most common groups. There are also mosses such as Rhacomitrium sp.. In small patches of fines among the boulders are found Saxifraga escholtzii, S. tricuspidata, S. oppositifolia. In wetter snowpatch areas Boykinea Richardsonii, and Saxifraga mertensiana are found.

There are less stable gravels found below permanent snowfields, where sheetwash processes remove fine sediments and organic detritus. Here grows Saxifraga oppositifolia, Luzula sp., Papaver Hultenii, and others. Along permanent rivulets Saxifraga nivalis, S. punctata, S. rivularis, and others are common. Salix plebophylla is important on small hummocks with Equisteum arvense, Dodecatheon frigidum, and mosses. It is also important in succession on glacial silts. Here areas of fines are deposited and colonized by cotton-grass, and later mosses. There mosses form a complete ground cover, as the surface agrades. A bluegreen algae covers the ground surface of the area, and along with some mosses and liverworts holds the surface intact. This provides a suitable surface for higher plants such as Salix plebophylla, and other willows.

Vegetationally, the area is quite diverse. Forest, shrub meadows, wet areas, and high basins are all well-represented in the Arrigetch area. This reflects the heterogeneity of the environment, and the need for careful study of these habitats, to understand their ecology. Then the relationship between each habitat and human disturbance can be established.

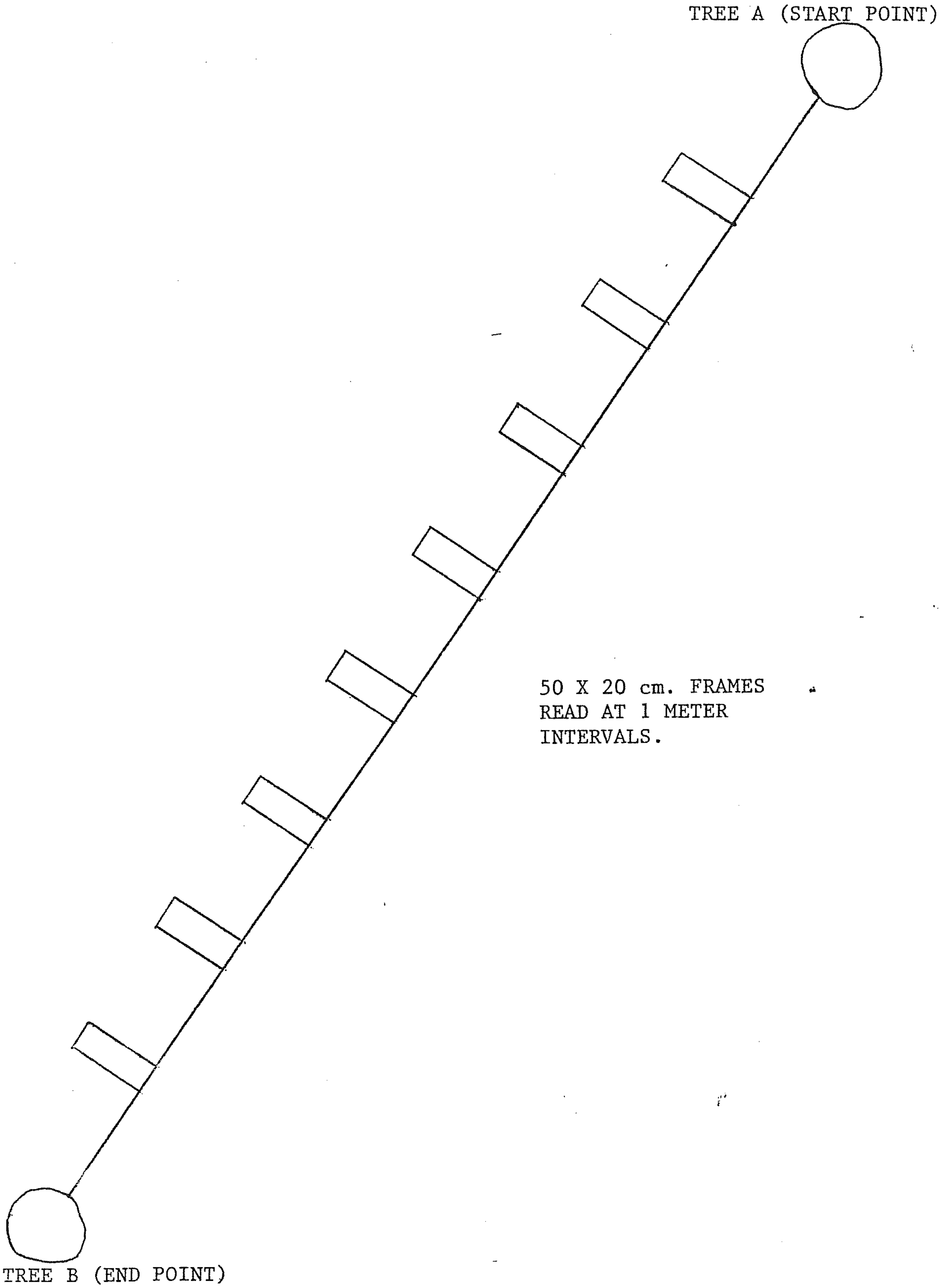
METHODS

Permanent transect lines were established along which the same plots of vegetation can be measured yearly. This will provide a yearly measure of vegetation characteristics along trails and camping areas. Of course there is yearly natural variance in species growth and visual characteristics, due to environmental variance. Thus it is essential to have parts of each transect in unimpacted areas to serve as a control for vegetation response to yearly environmental conditions.

This area is wilderness, and presumably will be managed as wilderness. The implanting of permanent stakes or construction of rock cairns to identify transect end points seems to be best way to locate transects, but is not an esthetically pleasing sight to visitors. The entire area is underlain by permafrost, and frost heaving of rocks makes them too mobile for permanent end points. Soil movement is also an active slope process, and downslope movement of any marker could cause the original transect line to be lost.

Mature trees were used as endpoints as they are the most permanent, stable, and natural markers in the valley. Each transect line runs between two trees. A meter tape is stretched from a starting point on one tree, along the ground in a straight line to either the left o~~f~~r right side of another tree. (see figure 1).

FIGURE 1


TREE A (START POINT)
50 X 20 cm. FRAMES
READ AT 1 METER
INTERVALS.
TREE B (END POINT)

A 20 X 50 centimeter frame (Daubenmire 1959) is used as the sample size, and the vegetation within each frame is described. The frame is placed with its long axis oriented perpendicular to the tape between centimeter 80 and 100 in each meter. Cover values for each species along with rock, litter, and bare ground are recorded. The cover value scale also follows Dauvenmire. + and - are used to indicate the top or bottom of the cover class.

VALUES FOR COVER ESTIMATION TECHNIQUE

Cover class	Range of Coverage,%	Midpoint of cover class,%
1	0-5	2.5
2	5-25	15.0
3	25-50	37.5
4	50-75	62.5
5	75-95	85.0
6	95-100	97.5

All vascular plants and nomenclature are those recognized by Hultén. Due to the complexity of cryptogam taxonomy, we are waiting to compare our collection with a verified collection. These are being identified by William Steere, University of Michigan. These additions will be forwarded as soon as they are received.

Plus or minus signs may be used for more accurate description of the coverage value of a species. For example a 2+ signifies a cover value between 15.0% and 25.0%. A 2- would indicate a cover value between 5.0% and 15.0%. A plus (+) alone means the species is present but not in significant quantity to warrant a cover value of 1.

TRANSECT LOCATION DESCRIPTIONS

All work is oriented from the main camp along Arrigetch Creek (see map #2). The largest tree in that area is used as the starting reference point (see photo pages 2,3,6). A meter tape, and a compass are needed to locate the transects.

On the downstream side of reference tree place the tape end against the base of the trunk between the two large horizontal roots (see figure #2). A nail or other marker should be emplanted here in the future to assure relocation. This point is the start for 4 transects; numbers 3,4,5, and 6. Stretch the tape to the closest spruce tree in the downstream direction. End the line in the center of the base of the trunk. This is approximately 6.5 meters long. This transect is designated as #3 (see map #3 and photo pages 1,2,3) The frame should be placed on the river side of the tape and read as specified in the Methods section.

Transect 4. From the same starting point stretch tape to contorted White spruce tree (see figure 3, map 3, photo pages 2,4,5), 12 meters uphill. This line should intersect a point at the downstream junction of the base of the tree. Read frames on the upstream side of the tape.

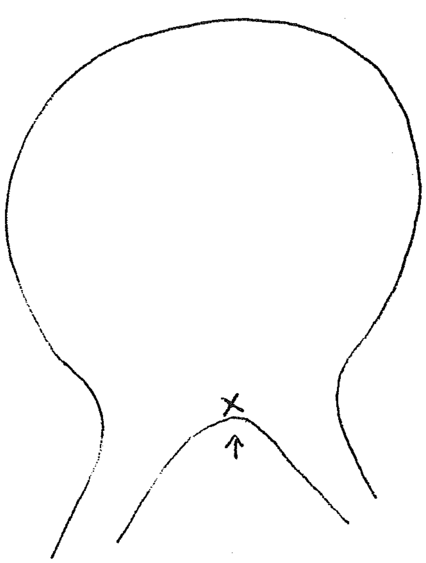


Figure 2

Figure 3
(also see photo page 5)

Transect 5. From the same point stretch tape uphill toward the downstream side of the left tree of a pair of White spruce trees at 90^{o} (read from a standard compass without declination set for this latitude). Read frames on the uphill side of the tape. This transect is 17 meters long (see map 3, and photo pages 2,4,5).

Transect 6. From the same start point run tape 15.5 meters to the uphill side of a White spruce located at 50^{o} direction. Read frames on the upstream side of the tape (see map 3, and photo pages 2,3).

Transect 7. From the most uphill point at the base of the crooked spruce tree (see transect 4), stretch tape to the uphill point of the trunk of a White spruce tree at 10 meters, and 70^{o} (see map 3, and photo pages 2,5). Read frames on the upstream side of the tape.

Transect 8. From the same start point as transect 7, to the uphill side of a White spruce tree at 13 meters and 150^{o} (see map 3, and photo pages 2,5). Read frames on the uphill side of the tape.

Transect 9. From the start of transect 8, fo to a White spruce tree at 24 meters and 200^{o}. Then to the next spruce at 210^{o} and 14 meters. From the closest point at the base of this tree to the uphill side of the next spruce at 14 meters and 235^{o} (see map 3, and photo page 1). Read frames on the upstream side of the tape.

Transect 10. From the end of transect 9, go at 190^{o} to the next spruce tree. Then 30 meters at 200^{o} to the tree with a double trunk. Then 210^{o} to another spruce tree. From the most upstream point of this tree to the streamside edge of a spruce tree at 200^{o} (see map 3, and photo page 1). Read frames on the uphill side of the tape.

Transect 1. Approximately 15 meters downstream from the main camp reference tree, locate 3 small spruce trees (see map 3, photo page 2). The tallest tree is approximately 5 meters tall, and is on the southeast

DISCUSSION OF TRANSECT DATA

In the transect area Dryas integrifolia seems to be quite important, covering large areas of the ground surface. It has tough branches and roots, and is highly resistant to trampling effects. The decrease in abundance of Dryas, and presence of large cover values of litter and bare ground indicate a high degree of trampling damage. This is clearly seen in transect data 5, frames 2-4. In some areas total destruction of the vegetation is obvious for example transect 4, frame 2.

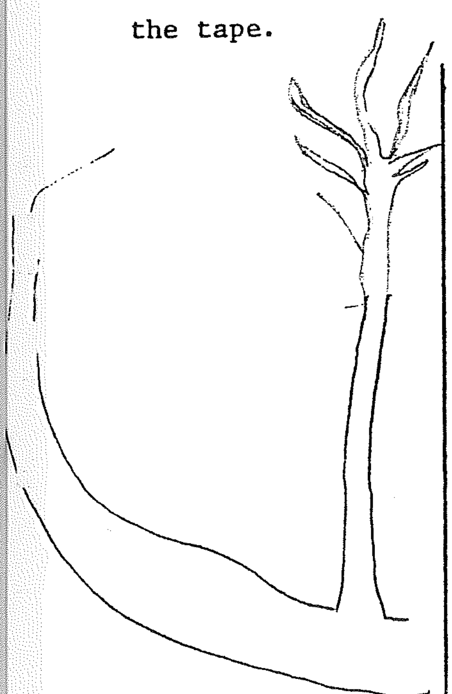
The change in cover values of plant species over time will be one obvious use of this data. The elimination of certain species which are more sensitive to trampling is another use.

At this time only characteristics of vegetation cover, bare ground and litter can be used to describe the trampling effects. Fruticose lichens especially Cladonia spp. and Cetraria spp. may be used in the near future as indicator species. They are easily broken and moved away by wind or water.

The entire area around transect 3,4,5, and 6 is severely impacted and it will be of vital interest to see whether this same type of impact will also be felt in other areas such as transect 7,8, and 9.

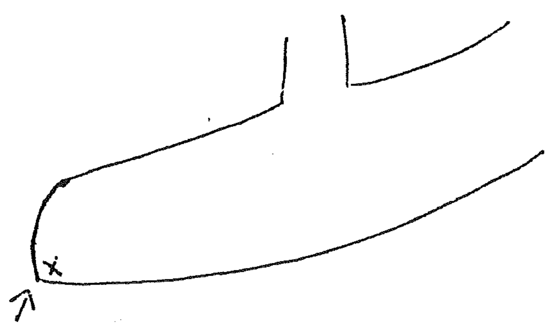
end of this transect. The tape is stretched from the most uphill point of this tree, around the downstream side to a small spruce tree of about 2 meters in height located toward the river. Pull the tape around this tree at ground level on the downstream side of this tree to a third small spruce tree. This tree is about 1.5 meters tall, and has had its top broken off. End the tape at the base of this tree. Read the frames on the upstream side of the tape.

Transect 2. Approximately 30 meters downstream from the main camp area locate a spruce tree (see figure 4, and map 3). On the downstream sode locate the junction of the main trunk with the hillside (see figure 5). Place the tape end here (X), and stretch along the ground 8 meters at 330^{o} to the corner (Y) of the large rock (see figure 6), with a willow shrub growing on its spstream side. Read frames on the upstream side of the tape.



as seen from
upstream

Figure 4



as seen from
downstream

Figure 5

as seen from
tree in figure 5

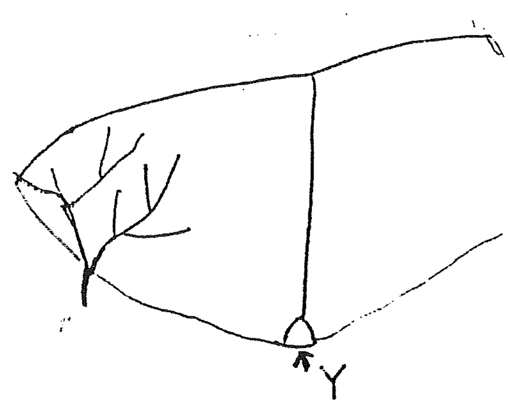
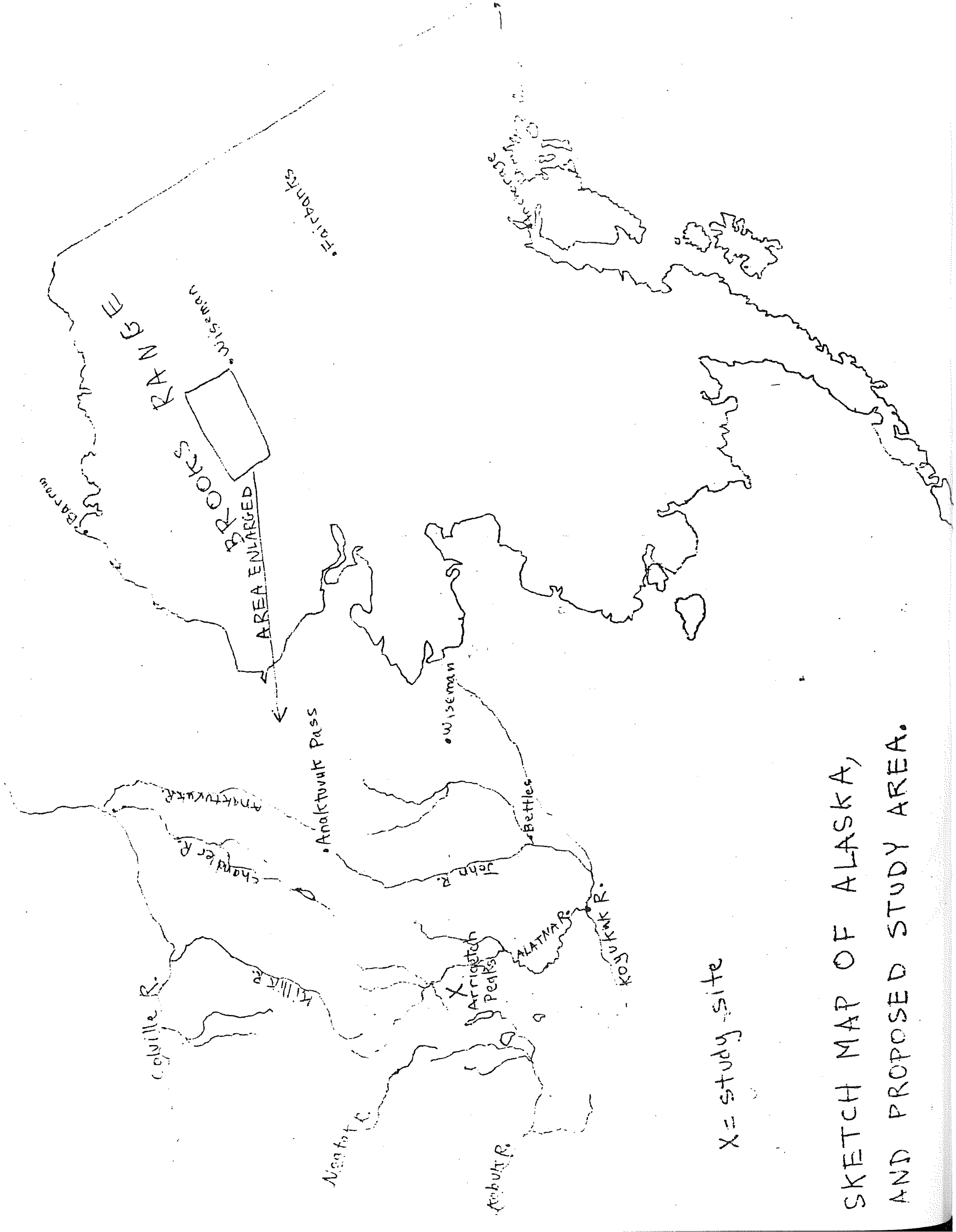


Figure 6

MAP #1: AREA OF INTEREST



SKETCH MAP OF ALASKA, AND PROPOSED STUDY AREA.

MAP #2: ARRIGETCH PLACE NAMES, AND LOCATIONS

MAP #3: TRANSECT LOCATIONS

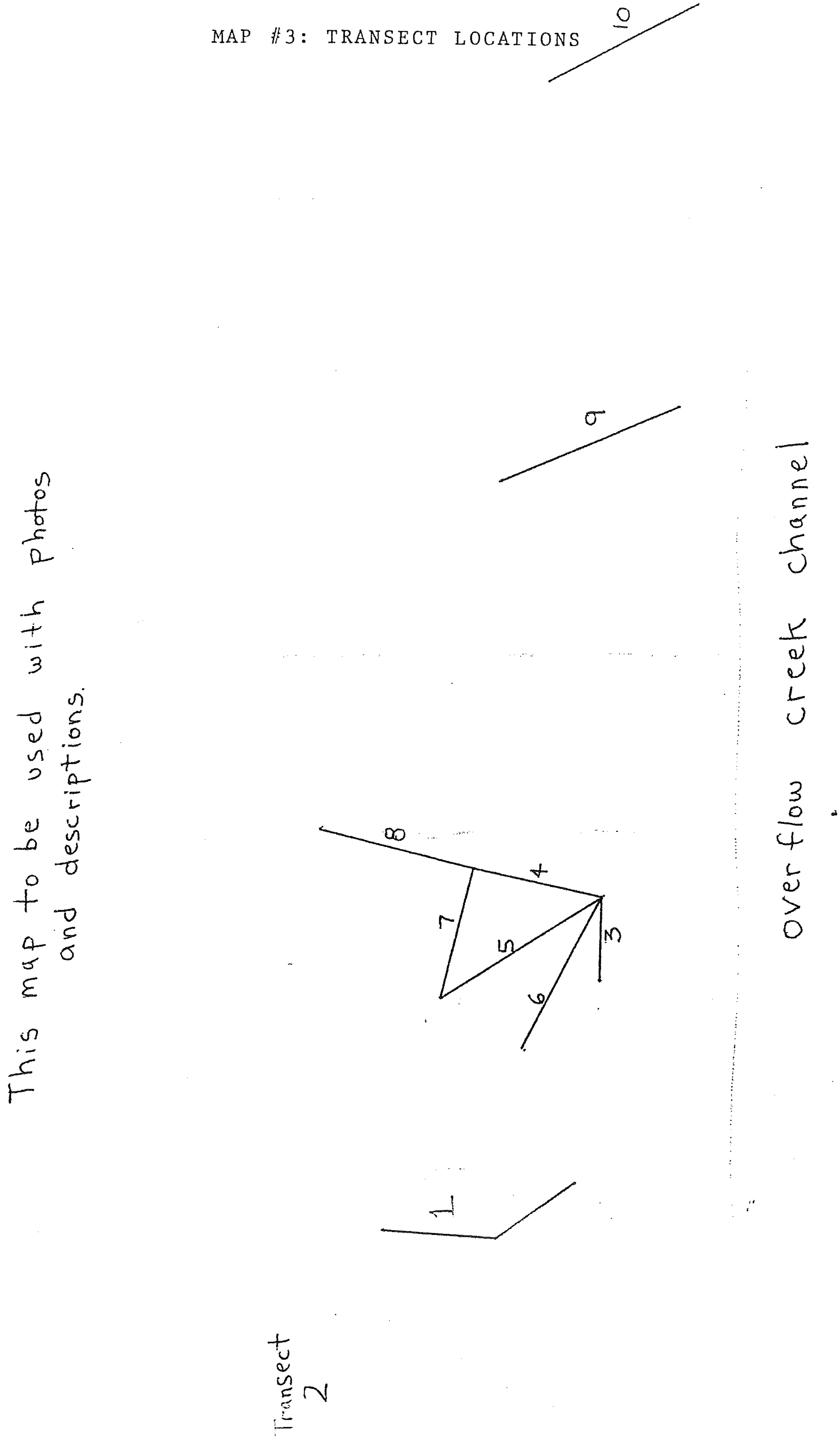
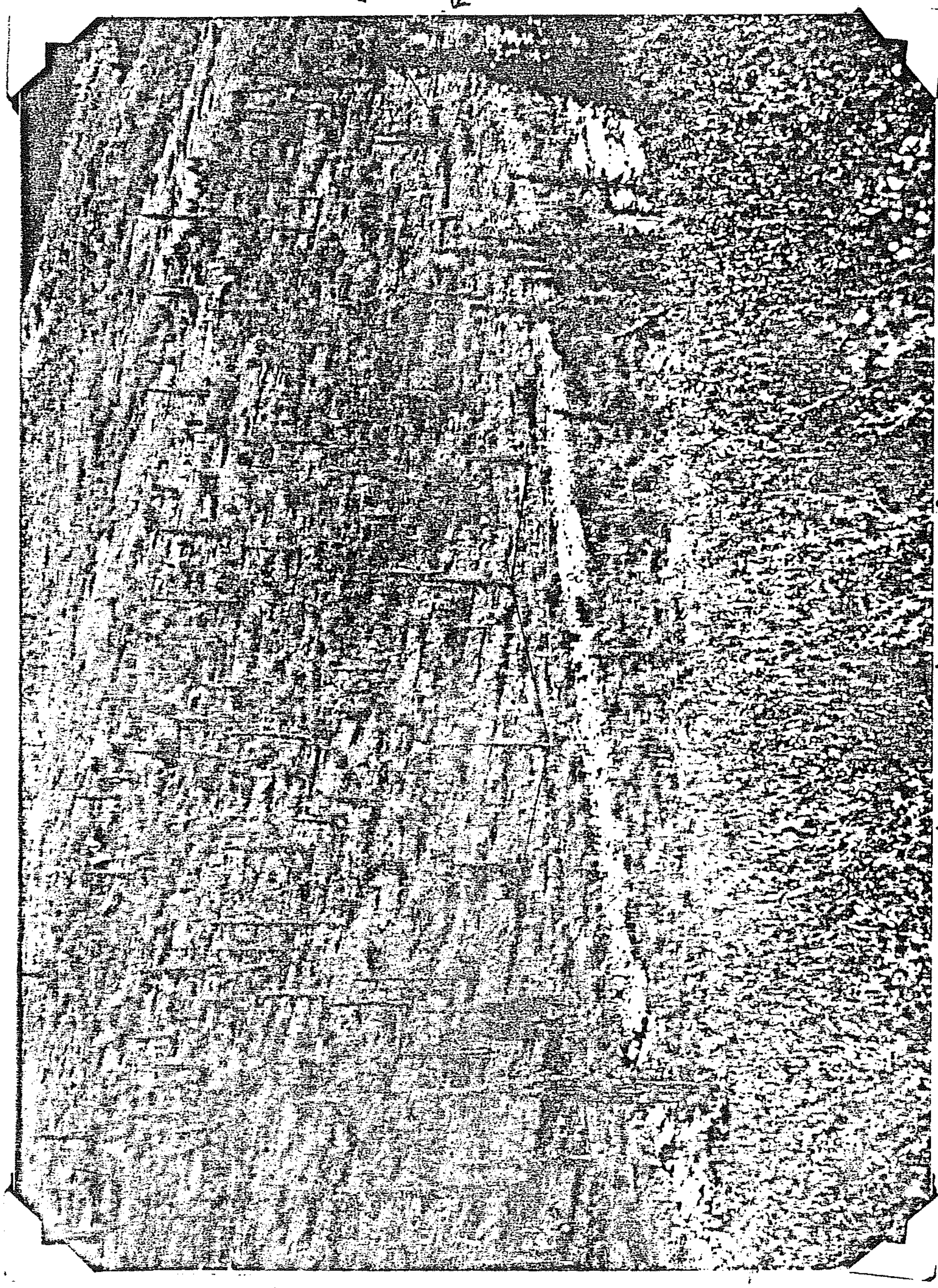
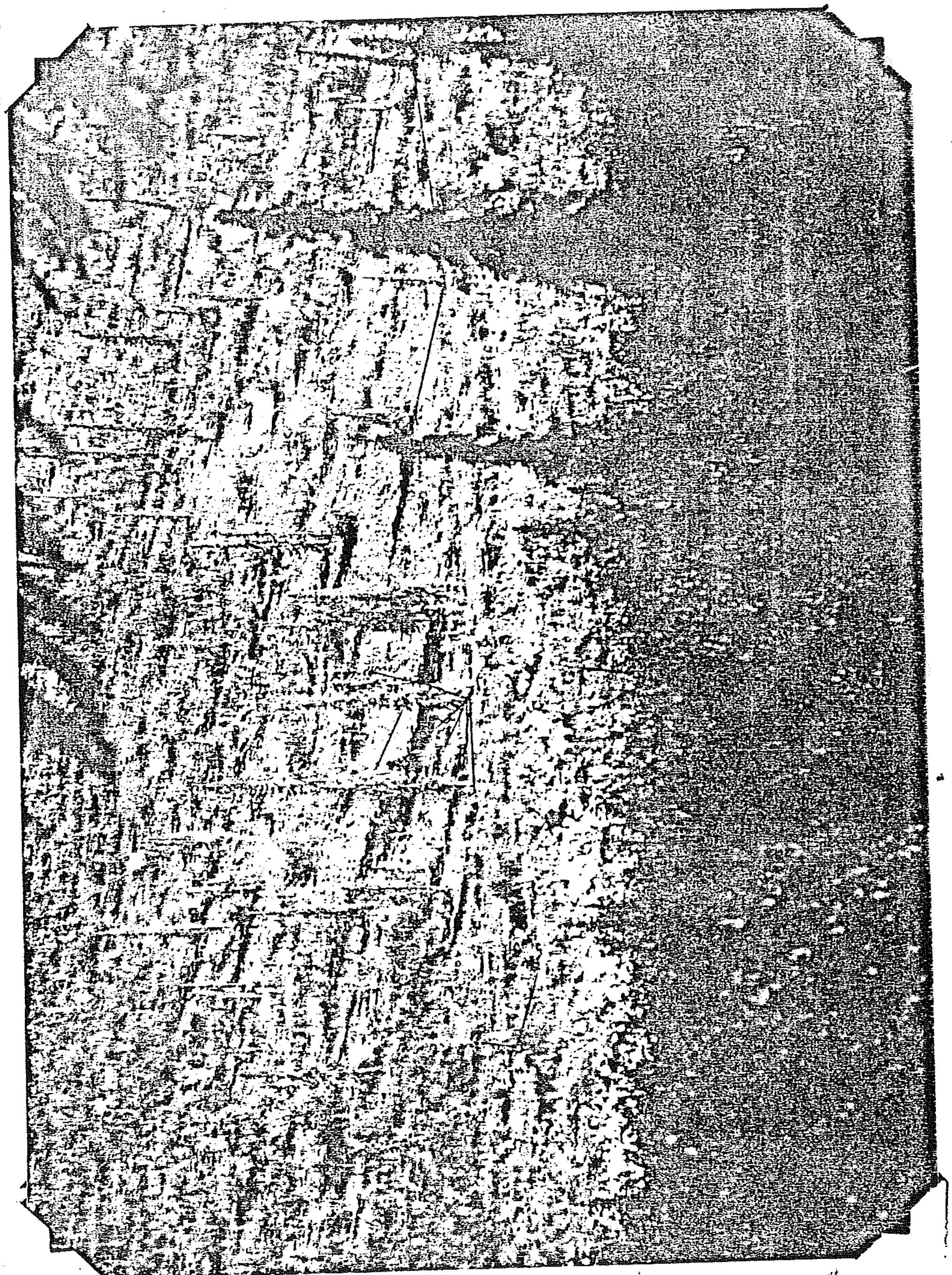


PHOTO PAGE 1



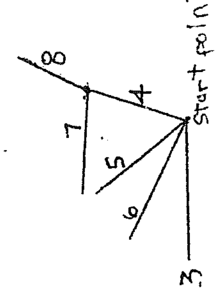
Spruce tree with double trunk
Start of transect 10
Transect 3
Transect 11 (no data for 1978)
Transect 12 (no data for 1978)
Transect 9

PHOTO PAGE 2



Transect 1 →

Transects →



Transect 6

Start point tree

Transect 3

PHOTO PAGE 4

← Transect 4

Transect 5 →

PHOTO PAGE 5

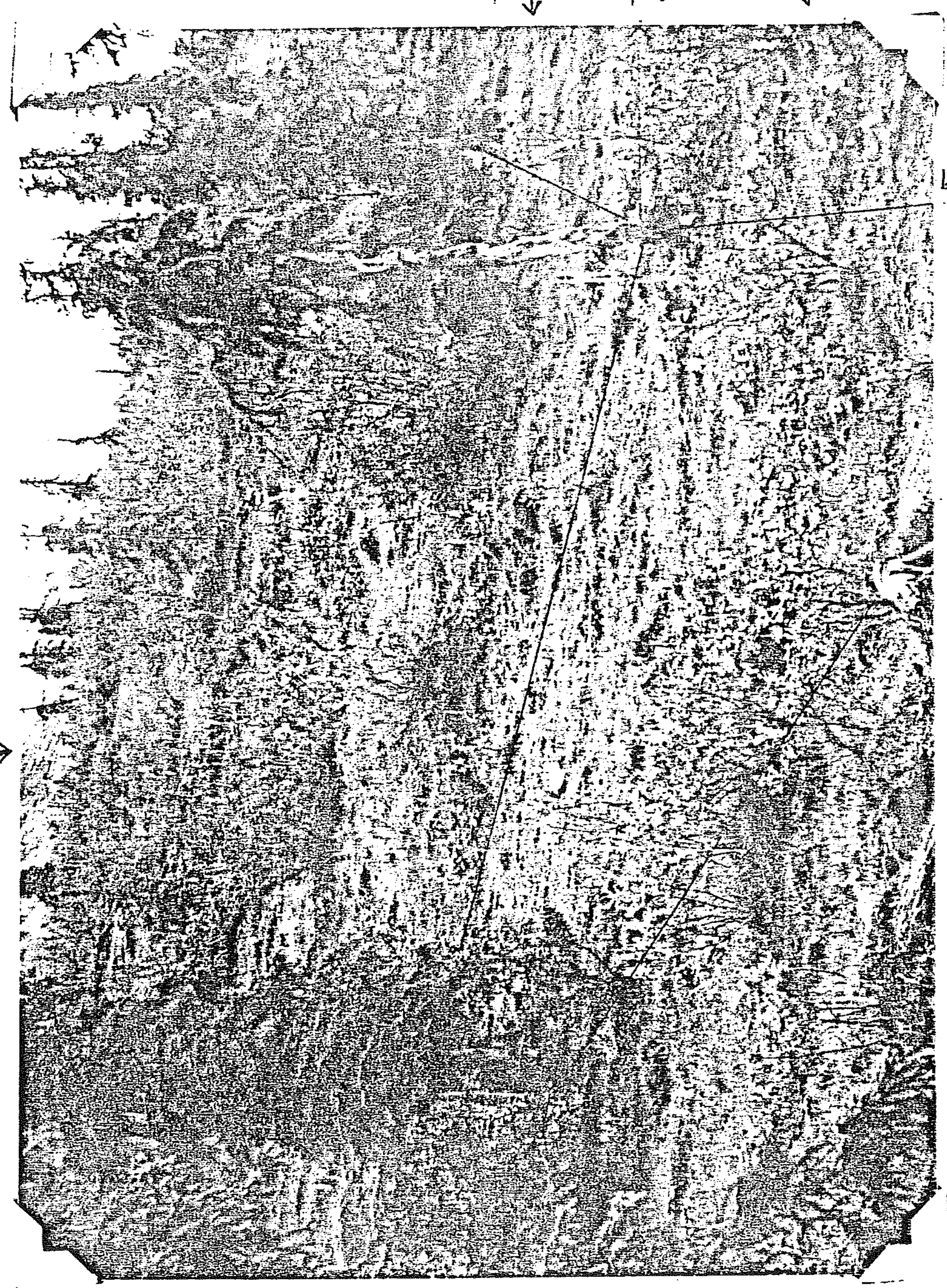
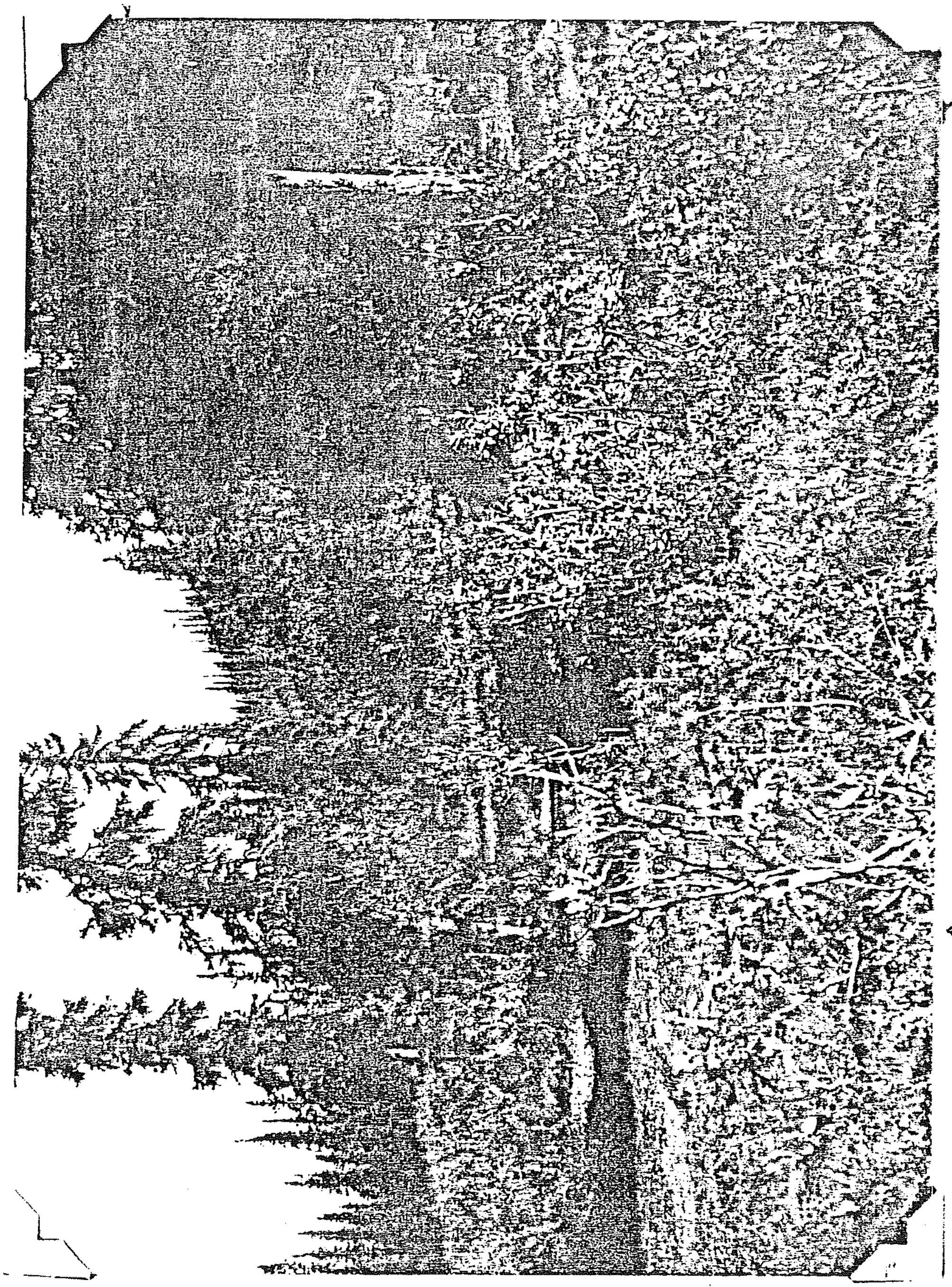

Transect 8
To transect 9
Transect 4
Transect 4
Transect 7
Transect 5

PHOTO PAGE 6



← Start point tree

TRANSECT 1

COVER VALUES OF SPECIES BY METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dryas integrifolia	2	3	4	1	4	4	3	3-	2	2	3	4	3	3
Carex scirpoidea	2	2-	1	1	1	1	+	1	1	2	+	1	1	1
Hedysarum alpinum	1	2-	3-	2	1	+	2	1	2	2	1	2	1	
Salix reticulata	1	3	3-		2	2		1	2	3	2	2	3	
Anemone parviflora	+	1-	+	1	1	+	+	+	+	1	1		1	1
Erigeron purpuratus	+				+			+					1	
Dodecatheon frigidum	+	+									1			
Potentilla fruticosa		2+				3								
Thalictrum alpinum		+	+		+	1-	+			1	1	1	1	1
Arctostaphylos rubra			2-	4		2	3				2		2	2
Salix alexensis				4					1	1			1	
Aster sibiricus						1	2	1	2		1		1	
Picea glauca						6								5
Polygonum viviparum								+						
Gentiana propinqua										1				
Zygadenus elegans											1			
Androsace chamaejasme														1
Litter	3	2	3	5	5	5	4	4	3	3	5	3	4	5
Bare ground	3		1	1	+	+		1	+		1		1	
Rock									2					
Cetraria islandica	1	1			+			+		1		+		
Cladonia pyxidata							+	1	1	1		1		
Cetraria cucculata												1		
Peltigera canina												1		
Stereocaulon alpinum											1			
Hylocomium splendens	1				+		+	+						
Hypnum sp.							+				1			
Dicranum sp.	+		+		+	+	+	+	+	1				
Pressia sp.												+		

TRANSECT 2

COVER VALUES OF SPECIES BY METER

	1	2	3	4	5	6	7
Dryas integrifolia	2	1	2	2+	3	4	3
Carex scirpoidea	1	1	1	1	2	1	
Salix reticulata	2	2	2	1			
Vaccinium uliginosum	+	2					
Arctostaphylos rubra	1	1	1	2	2		1
Pedicularis capitata	+						
Cassiope tetragona	+						
Anemone parviflora		+	+	+			
Erigeron purpuratus			1				
Saxifraga oppositifolia			1				
Potentilla fruticosa				2			
Shepherdia canadensis					3		
Litter	1	3	4	3	4	3	2
Bare ground		1	2-			2	
Rock							3
Cetraria islandica	1	3-		2			
Stereocaulon slpinum	+		+	2		+	
Cladonia pyxidata				+	1		
Hylocomium splendens	3				+		1
Thuidium abietinum		+					
Drepanocladus cf. uncinatus							2

TRANSECT 3

COVER VALUES OF SPECIES BY METER

	1	2	3	4	5	6
Dryas integrifolia	2	1		3	3	4
Hedysarum alpinum	1	1	1	1	2	1
Saussurea angustifolia		2-				
Salix reticulata		1+	1	2	2	2
Carex scirpoidea		2-	1	2	1	
Aster sibiricus		2-	1			
Epilobium latifolium		1	1			1
Anemone parviflora		+		+		1
Polygonum viviparum			1			
Thalictrum alpinum			+			
Potentilla fruticosa				1	3	1
Erigeron purpuratus					1	1
Litter	5	5	2	5	5	5
Bare ground			4	1		
cf. Cirriphyllum cirrosum				1		
Hypnum cf. revolutum						1
cf. Timmia sp.			+			+

TRANSECT 4

COVER VALUES BY METER

	1	2	3	4	5	6	7	8	9	10	11	
Dryas integrifolia	3		2	1	3	3	3		2	1	3	
Potentilla fruticosa	1			+								
Carex scirpoidea	1		1	2	1	1	1		1	1		
Salix alexensis			2				2			2	3	
Arctostaphylos rubra			1		1	1	3+					
Erigeron purpuratus			1									
Hedysarum alpinum			1		1	1						
Aster sibiricus				2-		1						
Saussurea angustifolia				1						1		
Salix reticulata				+	1		2		2			
Thalictrum alpinum				+								
Anemone parviflora				+		1	+	+	+	+		
Boykinea Richardsonii					3	1		1	1	2		
Epilobium latifolium					1							
Vaccinium uliginosum						1						
Saxifraga oppositifolia									1			
Pedicularis capitata									+			
Rock	1			+								
Litter	5	5	4	3	5	3	5	3	2	2	3	
Bare ground		1	2	3	1	3-		3			1	
Cetraria cucculata										+		
Peltigera canina									+			
Hylocomium splendens							1					1
Hypnum sp.						2-			1	3		
Cassiope tetragona												3

TRANSECT 5

COVER VALUES BY METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Dryas integrifolia			+	1	2	3	1	2	3	2	2	2	1	2	2	1
Carex scirpoidea		+	+	1	1	2	2	2	1	2	1				2	2
Polygonum viviparum			+													
Saussurea angustifolia			+	1	1				+	1	1	+			+	
Arctostaphylos rubra				+	1		1							4		
Thalictrum alpinum				+	1											
Salix reticulata				+	1	2	2		2		1	2				
Anemone parviflora				+	1	+	1	+	1		+	+			+	+
Epilobium latifolium				1												
Pedicularis capitata						1	1	+	+	+						
Salix alexensis						4										
Solidago multiradiata						1										
Vaccinium uliginosum						1										2
Boykinea Richardsonii							1	2					4			
Pedicularis Kanei									1	+	+					
Saxifraga oppositifolia									1							
Hedysarum Mackenzii									1	+		1		1	+	1
Cassiope tetragona									1		1			1		
Senecio lugens										1	1					
Dodecatheon frigidum										1						
Erigeron purpuratus										+		+				
Rock				1									1			
Litter		2	3	3	5	5	5-	4	2	4	3	2	3	4	4	2
Bare ground		4	3	2										1		
Cladonia pyxidata							1		1						1	1
Peltigera aphthosa							1		1							
Cetraria islandica									2-				1	1	1	1
Dactylina arctica														+		1
Cetraria cucculata															+	
Peltigera canina																1
Cladonia sp.							1		1						1	1
Parmelia intestiniformis														+		
Cladonia gracilis									1						+	1
Hypnum sp.					1	+		+	+							

TRANSECT 5 (cont.)

COVER VALUES BY METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hylocomium splendens					+	+										+
cf. Tomenthypnum nitens					+											
Dicranum sp.							+		+	+						1
cf. Drepanocladus sp.											2	2	2	1		1

TRANSECT 6

COVER VALUES BY METER

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dryas integrifolia	2			2	2+	+	2	2	2	2	3	2	2	2	1
Salix reticulata	1		1	3-	1		1	1			1	1	1	1	2
Hedyasrum alpinum	1			2-	1	1	2								
Carex scirpoidea	1			2-	2-	4	2	2	1		2	1	1	2	1
Aster sibiricus			1	1											+
Thalictrum alpinum				1	1	1				1					
Anemone parviflora					1	1	1	1		1	+		1	1	+
Potentilla fruticosa					1	2	+		+						
Epilobium angustifolium						1	1			1	1				
Dodecatheon frigidum						1	1	1	¯1		1				
Arctostaphylos rubra						1	2			2		+			2
Salix lanata							1								
Gentiana propinqua							+								
Equisetum variegatum								+	+		+				
Boykinea Richardsonii										4					
Pedicularis capitata										+			1	1	
Polygonum viviparum											1				
Senecio lugens											+	+			
Pedicularis Kanei												+			
Cassiope tetragona															1
Rock								+							
Litter	5	6	5	4	5	4	4	3	3	3	5	4	4	3	2
Bare ground	1		1				2	3	+		1	2			
Cetraria islandica						+	+		+						
Cladonia pyxidata								+				+			
Stereocaulon alpinum						+	+	+	2+		+			1	
Peltigera canina										+				1	
Cladonia gracilis											+	+		2	
Solorina sp.													+		
Cladonia sp.												+	+	+	
Hylocomium splendens				+	+									+	
cf. Hypnum sp.				+	+	+				2	+			+	
Timmia sp.								+							
cf. Tortella sp.							2								
Fissidens sp.							+								

TRANSECT 7

COVER VALUES BY METER

	1	2	3	4	5	6	7	8	9
Dryas integrifolia	2-	2-	2	3	1	2	3	3	2
Carex scirpoidea	1	2	2	2	2	1	2-	1	1
Cassiope tetragona	2				2				2
Arctostaphylos rubra	+								2
Salix reticulata		1	3	1					1
Saussurea angustifolia		1						1	
Saxifraga oppositifolia		1							
Hedysarum Mackenzii			+	+	1				
Anemone parviflora				1	1	1	1		+
Silene acaulis					4	2		1	
Pedicularis Kanei					+		+		+
Tofeldia coccinea					1	1			
Empetrum nigrum						1			
Polygonum viviparum							1		1
Vaccinium uliginosum									2
Litter	5	5	5	4	3	3	4	2	5
Bare ground		+		2	+		+		1
Cetraria islandica			1	+	1	1+	1	2	+
Cetraria cucculata			+			+			
Dactylina arctica			+		1	1+		1	+
Peltigera aphthosa					+				
Cladonia pyxidata								+	
Cladonia sp.			+	+	+	1	1	1+	
Cladonia gracilis								+	
Hylocomium splendens	1		1		+			+	
Dicranum sp.				1	+	2			1

TRANSECT 8

COVER VALUES BY METER

	1	2	3	4	5	6	7	8	9	10	11	12
Dryas integrifolia	2-		2	2	+	2	4+	3+	3	4-	2	1
Arctostaphylos rubra	2-		1	1	2	2		2				1
Salix reticulata	1	1	1	2	1	2-	2	1	1	2-	1	2
Cassiope tetragona	1						1	1+	1			2
Carex scirpoidea	1	1	1-			2	1	2			1	1
Hedysarum alpinum	1				1		1	2	1			
Saussurea angustifolia		1		1		2						
Shepherdia canadensis		+										
Vaccinium uliginosum		+										
Silene acaulis			1	2	4-				2	2-	2	
Senecio residifolius	+											
Senecio lugens			+	2							1	1
Epilobium angustifolium				2	1							
Anemone parviflora				1		1		+	1		1	1
Saxifraga oppositifolia				+	+		1					
Boykinea Richardsonii					1							
Salix sp.								3				
Pedicularis Kanei												+
Rock				2								
Litter	5+	4	3	2	3	2	5	3	4	4	4	2
Bare ground		2	4	4		2			1			
Cetraria islandica						3	1	1		1	1	
Cetraria cucculata								1				+
Cetraria Richardsonii						1	1				1	
Peltigera aphthosa						1						
Dactylina arctica								+		1	1	
Cladonia gracilis						+	+	+				
Cladonia sp.											1	1
Hylocomium splendens	+	+										
Drepanocladus sp.		+	+		1			+	1	1		
Bryum sp.			+	+		+					1	
cf. Pressia								+				
Brachythecium sp.										1		

TRANSECT 9

COVER VALUES BY

	1	2	3	4	5	6	7	8	9	10	11	12	13
Salix lanata	2								3				
Dryas integrifolia	2+	2	2-								2	1	2
Carex scirpoidea	3-	1	2-	1+	3						+	1	2
Salix reticulata	2	1	2-	1+	2	2	1	2+	5-	2+	1+	1	1
Anemone parviflora	1	1	+		1	1			1	1	+	1	1
Arctostaphylos rubra	1	1	1	+						1			1
Thalictrum alpinum	1	1	1	1				1		1		1	1
Equisetum variegatum	+	1	1	1-	1	1	1	1	1	1	+	1	
Equisetum scirpoides	+												
Polygonum viviparum	+			+	+	1	1	1					
Hedysarum Mackenzii	+	+											
Vaccinium uliginosum		2	3						1	1	2-	1	2+
Dodecatheon frigidum		1		1	1	1					1+	1	
Minuartia sp.		2-											
Hedysarum alpinum				1-									
Silene acaulis				1								1	
Saxifraga oppositifolia					1					1	1	1	1
Carex membranacea						3	3	3	2-	3	1		
Potentilla fruticosa							1	1		2-			
Litter	2	3	3	1-	1	2	2	4	4	4	1	3	5
Bare ground				4+	3	3	1						
Cetraria islandica	2	2										+	
Hylocomium splendens	2		1										

TRANSECT 10

COVER VALUES BY METER

	1	2	3	4	5	6	7	8	9	10
Picea glauca	4									
Arctostaphylos rubra	1	2	1							2
Vaccinium uliginosum	1	2								
Hedysarum alpinum	1	1	1	+	1	1	+		1	
Dryas integrifolia	1	3	2	2+	3-	3	2+	2	3	4+
Salix reticulata		2	2	1	2				2	
Cassiope tetragona		1			1			1		2-
Silene acaulis		1	1	1	2		4			
Hedysarum Mackenzii		+								
Anemone parviflora		+	+	+			1	1	+	1
Rock		1		1						
Litter	6	3	4+	3	3	5	3	5	4+	
Bare ground		2		3	1		2		1	
Cetraria islandica	+	1	2+	1+	+	1		1	1	
Cladonia sp.	+	1	1		+	+	+			
Dactylina ramulosa		+	1							
Cladonia gracilis		+	+		+					
Stereocaulon alpinum			+			1		1		
Peltigera canina			+				+			
Dactylina arctica					+		1			
Solorina sp.							+			
Pedicularis Kanei			1			1				
Saxifraga oppositifolia			1							
Carex scirpoidea				2-	+	2-	1	1	1	1
Tofeldia sp.				1	+	1		1		
Saussurea angustifolia										1
Epilobium angustifolium									1	
Polygonum viviparum								+		
Pedicularis sp.								+		
Erigeron purpuratus						1				
Boykinea Richardsonii									+	1

VASCULAR PLANT LIST FOR TRANSECT AREA

Androsace chamaejasme Host subsp. Lehmanniana (Spreng.) Hult.

Anemone parviflora Michx.

Arctostaphylos rubra (Rehd.&Wilson) Fern.

Aster sibiricus L.

Boykinia Richardsonii (Hook.) Gray

Cassiope tetragona L. D.Don subsp. tetragona

Dodecatheon frigidum Cham.& Schlecht.

Dryas integrifolia M.Vahl subsp. integrifolia

Empetrum nigrum L. subsp. hermaphroditum (Lange) Bocher

Epilobium angustifolium L. subsp. angustifolium

Epilobium latifolium L.

Equisteum scirpoides Michx.

Equisetum variegatum Schleich. subsp. variegatum

Erigeron purpuratus Greene

Gentiana propinqua Richards. subsp. propinqua

Hedysarum alpinum L. subsp. americanum (Michx.) Fedtsch.

Hedysarum Mackenzii Richards.

Minuartia sp.

Pedicularis capitata Adams

Pedicularis Kanei Durand subsp. Kanei

Pedicularis sudeticaWilld. subsp. albolabiata Hult.

Picea glauca (Moench) Voss

Polygonum viviparum L.

Potentilla fruticosa L.

Salix alexensis (Anderss.) Cov.

Salix lanata L.

Salix reticulata L.subsp. reticulata

Saussurea angustifolia (Willd.) DC.

Saxifraga oppositifolia L. subsp. oppositifolia

Senecio lugens Richards.

Senecio resedifolius Less.

Shepherdia canadensis (L.) Nutt.

Silene acaulis L.

Solidago multiradiata Ait. var. multiradiata

Thalictrum alpinum L.

Tofieldia coccinea Richards.

Vaccinium uliginosum L. subsp. alpinum (Bigel.) Hult.

Zygadenus elegans Pursh

LITERATURE CITED

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northw. Sci. 33:43-64.

Hulten, E. Flora of Alaska and Neighboring Territories. A Manual of the Vascular Plants. Stanford University Press, Stanford California. 1968.

APPENDIX A

REASON FOR SITE SELECTIONS AND QUALITATIVE ESTIMATE OF IMPACT AT EACH TRANSECT

The "main camping area" at treeline is the site of this initial study of human modification of Arrigetch Creek ecosystems. Six of the ten transects (#'s 3-8), for which quantitative data was collected in the summer of 1978 are clustered in and around this site. Two transects were established at different distances downstream (#'s 1 and 2), and two upstream (#'s 9 and 10). Two other transects were established upstream from the main campsite, but data was not collected. The ten transects do provide adequate representation of present vegetation. The greatest impact is and will continue to be around the main camping area, as many activities that result in modification of vegetation are concentrated there. That is the reason for the tight cluster of transects in that area. Most other impacts are narrowed to trails as visitors hike from camp to other sections of the valley. It will be quite important to monitor the intensity of impact at the main camp and watch the spread of denudation. Also the amount of trail use, off trail use and widening of trails will be reflected in the transects at some distance from the main camp.

Again let me emphasize that this is the initial year of this study and more data and more transects will have to be established before definite results and conclusions can be made for these Arrigetch ecosystems. Right now I believe there is a need for several transects at distance from the main camp in areas where there are no trails. This will provide a more quantitative estimate of what undisturbed vegetation in the area is like.

Transects 3-8 were chosen because they are in and around the main campsite. Each transect spans an area between two spruce trees. These transects reflect activities around camp, and are slightly off the trail. These transects thus run upslope, from 3-8, away from the trail and further away from the heaviest impact area which is centered on transects 3 and 4.

The site for transect three was selected because it is in the main impact area. Variation can be seen in cover values for plant species from meter 1-6. There is greater impact at meters 1-3 than at 4-6. This can be seen in cover values of *Dryas interrifolia*, *Salix reticulata*, and *Potentilla fruticosa*. This is a trampling gradient with impact ranging from total denudation to heavy.

Transect four was also chosen because it crosses the heaviest use area. Interestingly this transect has several areas of tall willow, *Salix alexensis*, and dense tall herbs in one spot (*Boykinea Richardsonii*). These areas are avoided by visitors (who walk around the shrubs), and increased cover values of all plants can be seen in meters 3-7, especially *Carex scirpoidea*, and *Dryas*, which reflect the lack of use of these micro-sites. In all photographs a dense turf of vegetation can be seen under shrubs within the denuded area. This probably reflects remnants of pre-man vegetation densities. Impact along this transect is extremely heavy in areas not "guarded" by shrubs, or other tall vegetation.

Transect five is a long transect, 16 meters, and was chosen to show how vegetation can change in moving from an area of heavy impact to an area of considerably less impact. Very few species are present in the first three meters of the transect. From there outward the cover values and diversity of species increases. Also seen is the addition of lichens with distance as seen in *Cetraria islandica*. Impact here is total denudation to moderate.

Transect six was selected for similar reasons as number five, and reflects similar processes. Vegetation here is moderately to completely disturbed.

Transect seven was chosen because it runs parallel to the zone of heavy impact. Transects five and six run perpendicular to this zone, starting in the area of heaviest impact and running toward areas of lesser impact. This transect shows the status of vegetation 11 meters away from the area of greatest impact. There is consistent coverage of Dryas integrifolia, Carex scirpoidea, and the lichens Cetraria islandica, and Dactylina arctica. This area is moderately heavily impacted.

Transect eight runs farther away from the heavy impact area. Cover values for Dryas, Arctostaphylos rubra, and Salix reticulata are consistently higher than in the other transects in this area (#'s 3-7) and reflect decreasing modification of the vegetation from its natural vigor and characteristic density. Small herbs and lichens are constant throughout the transect. Impact here is heavy (in meter 2) to moderate over most of the transect.

Transect nine was chosen because it is at a greater distance from the main camp area, and because it runs across a trail that leads from the main camp,up the valley. This transect also crosses a wetter area, (meters 4-10), and it is the only wet area in the immediate area of study that is crossed by the trails. The change in environment can be seen in the presence and abundance of Dryas, Carex scirpoidea, Vaccinium uliginosum, Saxifraga oppositifolia being found almost entirely in the first few and last few meters of this transect. Carex cf. membranacea and Potentilla fruticosa are found exclusively in the central, wetter portion of the transect line. It will be important to see how human use will modify this type of site. Impact here is moderate with an increase in bare ground in the center of the transect.

Transect ten is at a greater distance from the main camp than was transect nine. Cover values here probably more closely reflect the natural potential of the site. Here also a lichen *Cetraria islandica* is common throughout the transect. This area is also traversed by a trail and impact here is moderate.

Transect one was chosen because it is downstream from the main camp area, and is crossed by 4 trails,as the valley trail system is braided in this area. It is an area of shrubs and vegetation covers river rocks and boulders giving it a hummocky appearance. Distinct trails are obvious at at 1, 5.5, 8, and 11 meters along this transect. Bareground is obvious in the trail beds, but use is so diffuse through the area that no one part of the transect is extremely heavily impacted. Impact is moderate and the trails are distinct ribbons of completely denuded ground.

Transect two is farther from the main camp than transect one. Transects one and nine represent vegetation at one distance from the main camp area, and transects two, and ten represent vegetation at a greater distance. At this transect impact is moderate with most of the coverage and production being provided by woody stemed species such as *Dryas*, *Salix reticulata*, *Arctostaphylos rubra*, and fibrous rooted species such as *Carex scirpoidea*.